SAIC
Software Development Plan
for the
Clouds and the Earth's Radiant Energy System (CERES)
Data Management System

Version 4

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Document Revision Record

The Document Revision Record contains information pertaining to approved document changes. The table lists the Version Number, the date of the last revision, a short description of the revision, and the revised sections. The document authors are listed on the cover.

Document Revision Record (1 of 2)

Version Number	Date	Description of Revision	Section(s) Affected
V0.1	01/20/2006	• Initial version of the CERES Software Development Plan. • Updated format to comply with standards.	All All
V0.2	02/2006	• Updated to address defects and suggestions from the peer review. • Updated format to comply with standards.	All All
V0.3	03/19/2006	• Changed organization of document to match process flow instead of CMMI process areas. • Updated format to comply with standards.	All All
V0.4	03/21/2006	• Removed Section 2 and incorporated information in introduction of Section 2 through 5. Included additional clarification and corrections. • Updated format to comply with standards.	All All
V0.5	04/4/2006	• Updated text especially concerning verification and validation. • Updated format to comply with standards.	All All
V1	04/12/2006	• Added text and figures (new Section 1.1) and modified text throughout the document as a result of two-day mini review. • Updated format to comply with standards.	All All
V2	07/19/2006	• Modified reference numbers. • Made spelling correction. • Changed CERES PAL to ASRATSS iSTARS. • Deleted duplicate reference. • Updated format to comply with standards.	3.5 7.0 7.0 Ref. All
V3	08/08/2006	• Linked section numbers in table and figure to their corresponding sections. • Updated format to comply with standards.	Table 1-2 and Figure 1-3 All

Document Revision Record (2 of 2)

Version Number	Date	Description of Revision	Section(s) Affected
V4	09/15/2006	• Modified the title on the cover page to show association with SAIC instead of NASA. • Modified introduction to point to the SAIC Common Approach for Software Development and Maintenance. • Modified References 4 (Data Management Plan) and 8 (Configuration Management Plan) to reflect updated titles showing association with SAIC instead of NASA.	Cover page Section 1.0 References

Preface

The CERES DMS supports the data processing needs of the CERES Science Team research to increase understanding of the Earth's climate and radiant environment. The CERES DMT works with the CERES Science Team to develop the software necessary to support the science algorithms. This software, being developed to operate at the Langley ASDC, produces an extensive set of science data products. The DMS consists of 12 subsystems; each of which contains one or more PGEs.

The plan's purpose is to provide specific guidance and definition of the Software Development Process used by the CERES DMT. The CERES DMP provides overall guidance to the CERES DMT.

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1.0 Introduction

CERES is a key component of EOS. The CERES instrument provides radiometric measurements of the Earth's atmosphere from three broadband channels: a shortwave channel (0.3 - 5 μm), a total channel (0.3 - 200 μm), and an infrared window channel (8 - 12 μm). The CERES instruments are improved models of the ERBE scanner instruments, which operated from 1984 through 1990 on NASA ERBS and on NOAA operational weather satellites NOAA-9 and NOAA-10. The strategy of flying instruments on Sun-synchronous, polar orbiting satellites, such as NOAA-9 and NOAA-10, simultaneously with instruments on satellites that have precessing orbits in lower inclinations, such as ERBS, was successfully developed in ERBE to reduce time sampling errors. CERES continues that strategy by flying instruments on the polar orbiting EOS platforms simultaneously with an instrument on the TRMM spacecraft, which has an orbital inclination of 35 degrees. In addition, to reduce the uncertainty in data interpretation and to improve the consistency between the cloud parameters and the radiation fields, CERES includes cloud imager data and other atmospheric parameters. The CERES instruments fly on the TRMM spacecraft and on the EOS Terra and Aqua platforms. The TRMM satellite carries one CERES instrument while the EOS satellites carry two CERES instruments, one operating in a fixed azimuth scanning mode and the other operating in a rotating azimuth scanning mode.

The CERES DMT is responsible for the development and maintenance of the software used to process the data received from the on-orbit CERES instruments. For the purposes of this document, product refers to the CERES software delivered to the ASDC and is not to be confused with CERES data products, which are created by the CERES software.

The CERES project management and implementation responsibility is at NASA Langley. The CERES Science Team is responsible for the instrument design and the derivation and validation of the scientific algorithms used to produce the data products distributed to the atmospheric sciences community. The CERES DMT is responsible for the development and maintenance of the software that implements the science team's algorithms used in the production environment. The Langley ASDC is responsible for the production environment, archival and distribution of the CERES data products generated at NASA Langley.

This document is prepared in accordance with the SAIC Common Approach to Software Development and Maintenance. Documents describing this approach can be found at https://issaic.saic.com/infocapital/si/pal/casdm/. The purpose of the CERES Software Development Plan is to describe the development of the CERES DMS by the CERES DMT.

This document is organized as follows:

Appendix A - Acronyms
Appendix B - Glossary
Appendix C - Customer Public Release of Data Products Checklist

1.1 Organization

The key organizational elements that are involved in the CERES software development and data processing effort are shown in Figure 1-1. The CERES Science Team and WG chairs are included in the "Science" area. The CERES Data Management Team, subsystem leads, and subsystem personnel are included in the "Data Management" area. Members of the CERES working groups may be from the Science Team or Data Management Team. Typically, the NASA personnel are located at NASA Langley Research Center in Building 1250, and the contractor personnel are located in the off-site SAIC facility. The computer environment that supports both the Science Team and the Data Management Team in both locations is the SCF.

The goal of these teams is to prepare software which implements the CERES algorithms as defined by the CERES Science Team as represented in the data flow diagram shown in Figure 1-2 and to execute this software operationally to produce the CERES data products (see Reference 1). This operational data processing is conducted at the ASDC. The computer environment at the ASDC is referred to in this SDP as the production environment. The operational processing mentioned above then takes place in the operational production environment. In addition to operational data processing, software testing also is performed in the production environment as this is the computer environment where the operational data processing will ultimately take place.

1.2 CERES Software Development Process Flow

This Software Development Plan defines the processes followed by the CERES DMT while developing and maintaining the CERES DMS. Additional documents associated with the project provide the specific details regarding the data interfaces, processing algorithms, output products, instrument design and calibration, and science investigations as they are developed through the project life cycle. These documents are accessible from the CERES Home page (see Reference 2). The stages and steps of the CERES software development process flow can be seen in Figure 1-3. Each of these stages is described in detail in Section 2.0 through Section 5.0. The assignment of responsibility for each stage can be found in the CERES Software Development Responsibility Matrix shown in Table 1-1. The use of peer reviews are discussed in Section 7.0 since they are not associated with any particular stage.

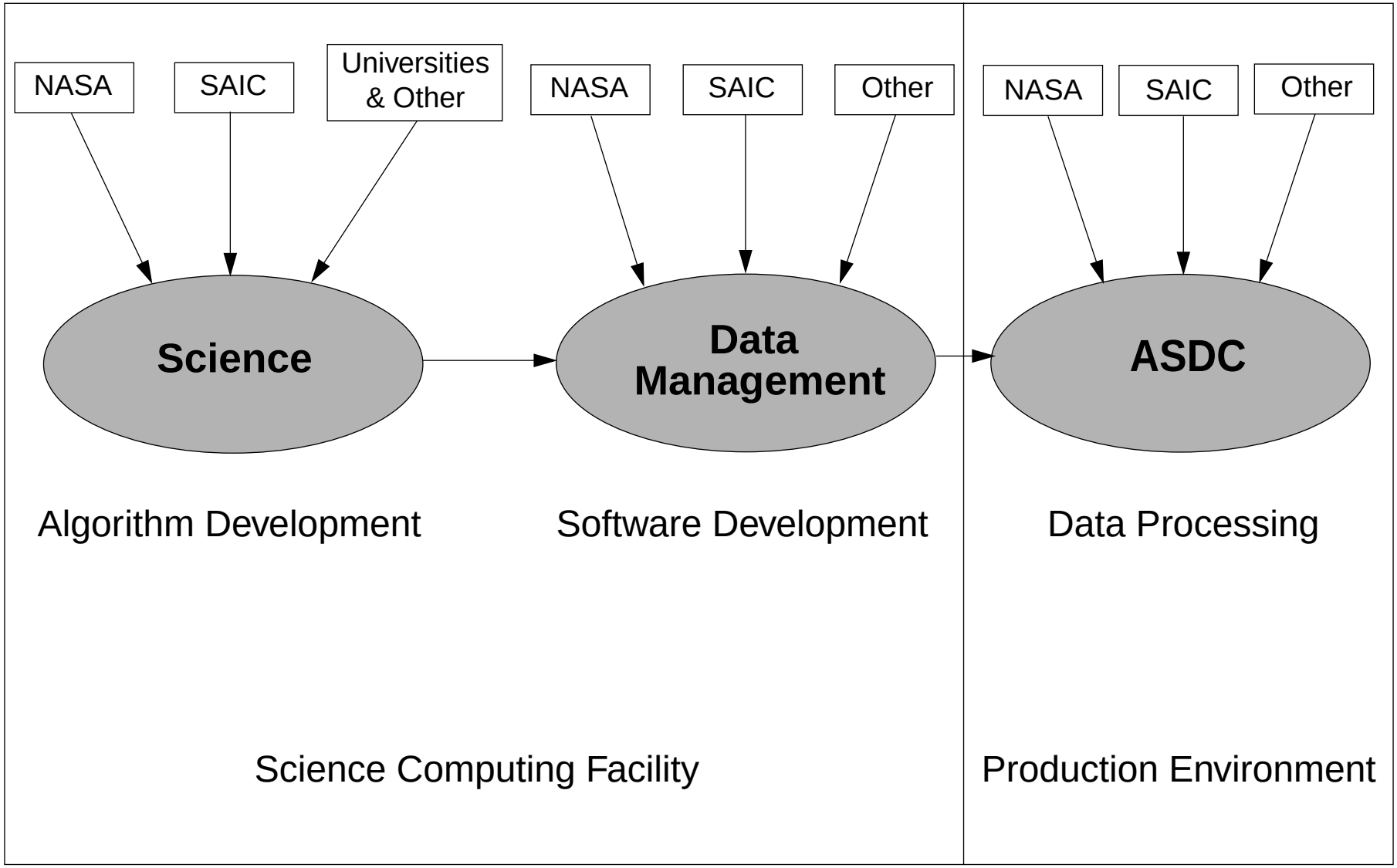

Figure 1-1. Organizational Components for CERES Software Development and Data Processing

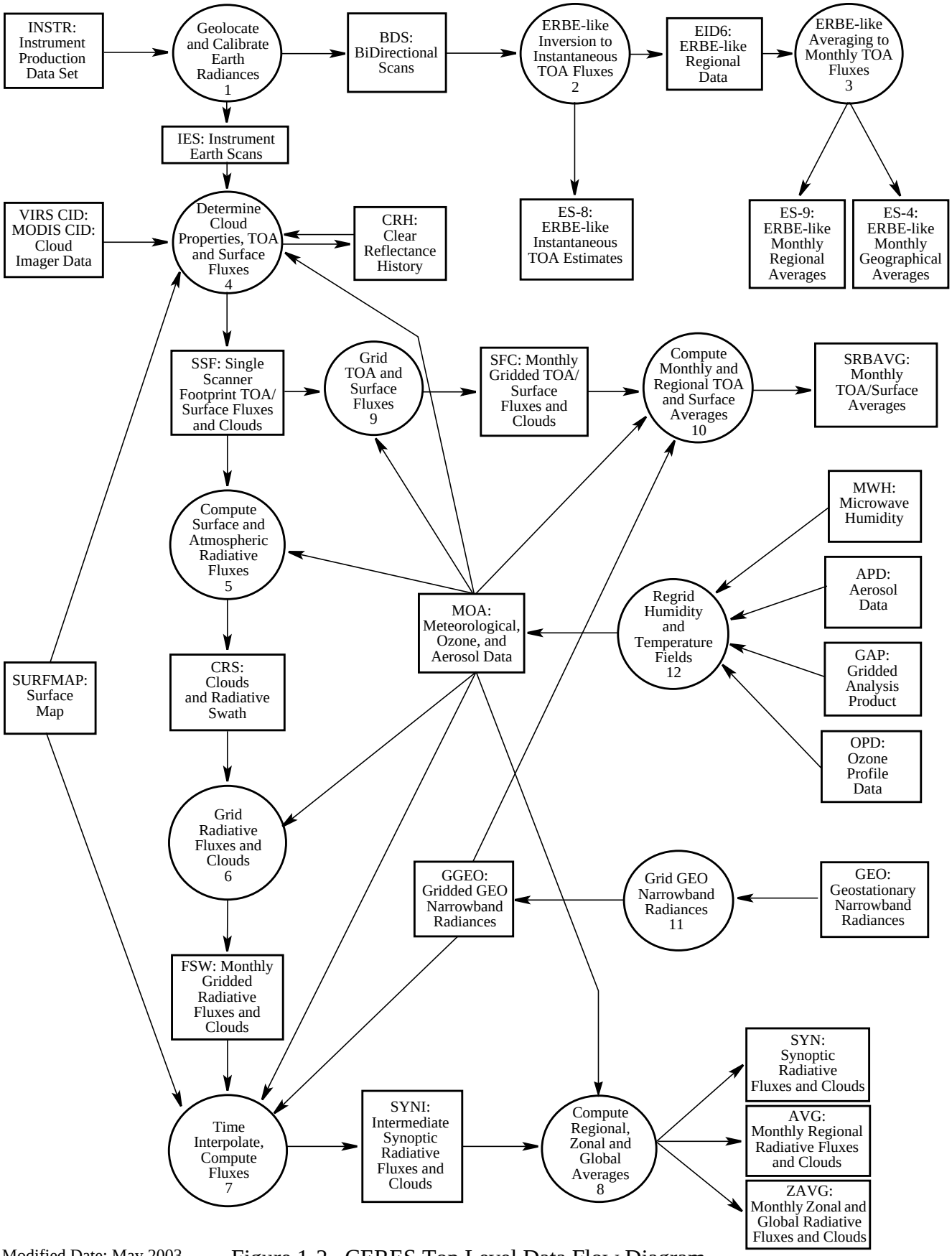

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Figure 1-2. CERES Top Level Data Flow Diagram

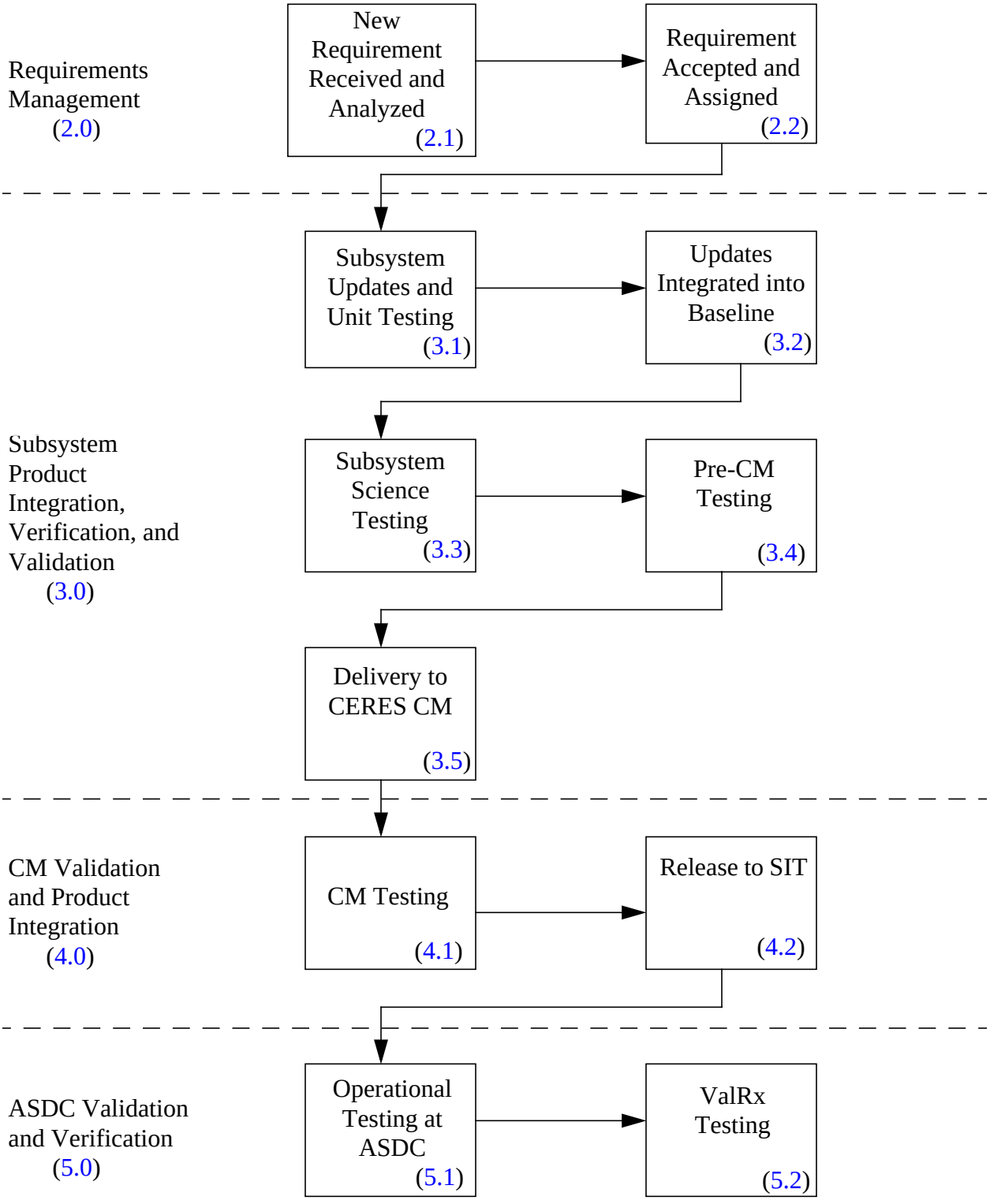

Figure 1-3. CERES Software Development Process Flow Diagram

1.3 CMMI Process Areas Mapped to CERES

Table 1-2 shows the CMMI Process Areas associated with each of the CERES software development steps as contained in Figure 1-3, which working level or organization (Process Environment) performs it, and in which computer environment the process is performed.

For reference the definitions of the Requirements Management, Product Integration, Verification, and Validation CMMI process areas are given below (see Reference 3).

The purpose of **Requirements Management** is to manage the requirements of the project's product and product components and to identify inconsistencies between those requirements and the project's plan and work product.

The purpose of **Product Integration** is to assemble the product from the product components, ensure that the product, as integrated, functions properly, and deliver the product.

The purpose of **Verification** is to ensure that selected work products meet their specified requirements.

The purpose of **Validation** is to demonstrate that a product or product component fulfills its intended use when placed in its intended environment.

1.4 ERBE Heritage

ERBE was a multi-satellite system designed to measure the Earth's radiation budget. The ERBE instruments flew on a low-inclination NASA satellite (ERBS) and two sun-synchronous satellites (NOAA-9 and NOAA-10). Each satellite carried both a scanner and a nonscanner instrument package.

ERBE software and concepts were reused by the CERES software development team. For example, the CERES Inversion and TISA Subsystems relied heavily on reused ERBE code. CERES also derived much of the initial set of CERES documentation and documentation standards from the documentation set developed for the ERBE project. A complete list of CERES Documentation can be found in the Data Management Plan (see Reference 4) and on the CERES On-Line Documentation Web site (see Reference 5).

Table 1-1. CERES Software Development Responsibility Matrix

Task	Subsystem Team	Subsystem Integrator	Science Team	CM Team	ASDC
New Requirement Received and Analyzed	P	S	S		
Requirement Accepted and Assigned	P	S	S		
Updates made and Unit Tested	P				
Updates Integrated into Baseline	S	P			
SS Science Testing	S	P	S		
Pre-CM Testing		P			
Delivery to CERES CM		P		S	
CM Testing		S		P	
Release to SIT				P	S
Operational Testing		S		S	P
ValRx Testing	S	S	P		P

P - Primary
S- Secondary

Table 1-2. CMMI Process Area

Section	CERES Process[a]	Process Environment	CMMI PA	Computer Environment
2.1	New Requirement Received and Analyzed	Subsystem	Requirements Management	SCF
2.2	Requirement Accepted and Assigned	Subsystem	Requirements Management	SCF
3.1	Updates Made and Unit Tested	Subsystem	Verification	SCF
3.2	Updates Integrated into Baseline	Subsystem	Product Integration	SCF
3.3	Subsystem Science Testing	Subsystem	Product Integration Verification	SCF
3.4	Pre-CM Testing	Subsystem	Validation	ASDC
3.5	Delivery to CERES CM	Subsystem	Product Integration	SCF
4.1	CM Testing	CM	Validation	ASDC
4.2	Release to SIT	CM	Product Integration	ASDC
5.1	Operational Testing at ASDC	ASDC	Validation	ASDC[b]
5.2	ValRx Testing	ASDC	Validation Verification	ASDC

a. From Figure 1-3.
b. Informational only, “Operational Testing at ASDC” is not a DMT specified process.

One of CERES four main objectives is “For climate change analysis, provide a continuation of the ERBE record of radiative fluxes at TOA, analyzed using the same algorithms that produced the ERBE data” (see the CERES brochure, Reference 6, available via http://earth-www.larc.nasa.gov/ceresdm/CAD/). To this end the ERBE Inversion and TSA Subsystems’ (combined scanner and nonscanner) software was actually used as the basis of the new CERES ERBE-like Subsystems. Some of the considerations in converting the ERBE to CERES ERBE-like code were

- remove nonscanner instrument data processing code
- port code from the Network Operating System to a Unix platform
- modify code to reflect the CERES, rather than the ERBE, instrument sampling rate
- modify code to spectrally unfilter the longwave window channel
- modify code to use the SDP Toolkit

“ERBE-like Products are as nearly identical as possible to those produced by the previous generation ERBE instruments. These products include broadband shortwave, longwave, and net radiative fluxes for both cloudy sky and clear sky conditions. ERBE-like products are used for climate monitoring and climate change studies when comparing directly to ERBE data sources” (see Reference 6).

2.0 Requirements Management Stage

The CERES DMT Requirements Management process consists of receiving, logging, analyzing, implementing, and tracking requirements from the CERES Science Team for creating and updating the CERES production software. The requirements management stage is broken into two tasks as shown in Figure 1-3: New Requirement Received and Analyzed (see Section 2.1) and Requirement Accepted and Assigned (see Section 2.2).

Since the publication of the ATBDs and for as long as new data sets are produced, new requirements for the CERES processing system continue to be generated. The requirements for modifications may come from the CERES Science Team, the leadership of the DMT, or be driven by outside influences such as new or updated equipment. New requirements are entered into the subsystem-level requirements log and managed according to the CERES DMT Requirements Management Plan (see Reference 7). The receipt of a new requirement initiates the process of preparing for a delivery of subsystem software to the ASDC.

2.1 New Requirement Received and Analyzed

A new requirement can be communicated in various methods, such as email, face-to-face meeting, during a Science Team or DMT meeting, or over the phone. These requirements are then entered into the appropriate subsystem's Requirements Log as per the Requirements Management Plan (see Reference 7). In conjunction with the Requirements Log an SCCR is created whenever a new requirement is added that may lead to an update to or creation of a new PGE. Further information on how to create/update an SCCR can be found in the CERES CM Plan (see Reference 8). The requirements are then analyzed to determine what impact the change will have on the delivery schedule, data product size, processing time, and available memory. The affect of the change on other subsystems and data products needs to be communicated to other subsystems and to the DMT Lead. The analyst should consider if their subsystem is the best place to meet the requirement.

2.2 Requirement Accepted and Assigned

The results of the requirement analysis will be given to the requirement provider, who has the option of authorizing the software update or not. If the requirement is not authorized, the appropriate subsystem's Requirements Log is updated to reflect this decision. Otherwise, the subsystem lead will assign an analyst to implement the change as described in the next section.

3.0 Subsystem Product Integration, Verification, and Validation Stage

Subsystem product integration, verification, and validation consist of the processes followed by the subsystem team after the receipt, analysis, acceptance, and assignment of a new requirement to implement and deliver the updated product to CERES CM. The subsystem product integration, verification, and validation are broken down into five tasks as shown in Figure 1-3: Subsystem Updates and Unit Testing (see Section 3.1), Updates Integrated into Baseline (see Section 3.2), Subsystem Science Testing (see Section 3.3), Pre-CM Testing (see Section 3.4), and Delivery to CERES CM (see Section 3.5).

At the subsystem level, a new requirement results in new software being developed or existing software being changed by an analyst. Once the changes are made, limited testing is performed to confirm that the changes are correct and meet the specified requirements. This is the first part of CERES subsystem verification described in Section 3.1 and shown in Figure 1-3. The modified code is then passed to the subsystem integrator for incorporation in the current baseline.

The subsystem product integration process ensures that the assembled product functions properly. The first part of CERES subsystem product integration consists of the integration of updates made to one or more modules into the subsystem's software baseline. It is the responsibility of the subsystem team to update the individual modules and deliver the tested updates to the subsystem's integrator for integration into the baseline. This process encompasses the task described in Section 3.2 as shown in Figure 1-3.

CERES subsystem science testing described in Section 3.3 as shown in Figure 1-3 falls under both the Product Integration and Verification process areas. The subsystem science testing is to ensure that the new or modified software, as integrated, functions properly (Product Integration - more of a solely DMT activity) and to ensure that it meets the specified requirements (Verification - more of a joint DMT and science team activity), in this case by using more complete test data sets than are available when performing unit testing. The subsystem science testing consists of performing a suite of tests determined by the scope of the updates being delivered for incorporation into the subsystem's software baseline. These tests are designed to determine if the new baseline creates the scientific results consistent with the requirements and acceptable to the WG chair. This effort involves the subsystem team and the appropriate WG chair. Subsystem science testing may also include peer reviews (Verification) of the updated software modules; peer reviews are discussed in Section 7.0 of this document.

The subsystem validation process ensures that the product will function in the ASDC production environment. It is possible that downstream subsystems may also be involved in this validation effort, as results of changes made to the science software may unexpectedly affect downstream subsystems. This process encompasses the tasks discussed in Section 3.4 as shown in Figure 1-3.

Delivery to CERES CM is the final step in product integration as described in Section 3.5 as shown in Figure 1-3.

3.1 Subsystem Updates and Unit Testing

Subsystem updates begin when a software change requirement is received and accepted. The analyst will work with the requirement provider on Science Team contributed software (see Section 3.1.1) or on DMT developed software (see Section 3.1.2). After the changes are completed, the software will be unit tested (see Section 3.1.3).

Any changes to the CERES DMS are first implemented at the SCF and tested by the appropriate subsystem team. Changes that are known or anticipated to impact an interface between subsystems are agreed upon by the Science Team and DMT before implementation. Testing between the impacted subsystems is coordinated by the subsystem leads.

3.1.1 Science Team Contributed Software

Many algorithms are provided to the CERES DMT as already coded modules developed by the Science Team while deriving the science algorithms. For this contributed software the job of the DMT analyst is to incorporate the code into the subsystem software with minimal changes (see Section 3.1.1.1). Examples include software developed to manage the inputs to and outputs from the contributed software. The only changes made to the provided modules by the DMT are those necessary to make the modules function in the ASDC production environment or to conform to EOSDIS standards (see Section 3.1.1.1). This allows the Science Team to maintain a parallel version for further refinement and for any changes to be easily communicated to and implemented by the DMT.

3.1.1.1 Standardize Contributed Code

Software contributed by the Science Team does not always need to be modified by the DMT. However, modifications must be made when the contributed software does not conform to the EOSDIS standards or does not function as expected once incorporated into the subsystem software. When modifications are necessary, the updates are discussed with the software provider to ensure that they are aware of the modifications being made and to allow the provider to make many of these modifications to future deliveries of updates to the software. Updates related to the SDP Toolkit will be made by the subsystem.

In addition, the following checks or changes are made to all software that will execute in the ASDC production environment:

- Replacement of non-Toolkit open and close utilities with Toolkit provided and/or CERESlib utilities.
- Replacement of non-Toolkit error message utilities with Toolkit provided and/or CERESlib utilities.
- Replacement of logic that results in underflow or overflow conditions.
- Replacement of logic that does not successfully compile or properly link to libraries used by the subsystem software.

3.1.1.2 Conveyance of Modifications to the Science Team

The DMT must convey any modifications that were necessary to the contributed software to the Science Team. This does not place any requirements on the Science Team to incorporate the updates into their version of the software.

3.1.2 DMT Developed Software

The DMT has the responsibility of providing the framework in which the scientific algorithms will function. The framework consists of software that reads input data sets and ancillary data, sequences the science algorithms, provides the necessary input, and writes output files. Within this framework are the data product interfaces that are maintained in CERESlib to ensure multiple subsystems have a consistent interface. Generally, the DMT will develop software that performs quality assurance of the data and generates quality control reports. Additionally, some algorithms are provided through the ATBDs or other communications, and the DMT is required to develop the software. Quality assurance and control and algorithm development require communication with the Science Team to ensure their expectations are met.

3.1.2.1 Required Software Attributes

Software developed or modified solely by the DMT are held to a higher standard than Science Team contributed code. It must meet the Software Coding Guidelines (see Reference 9) as well as meet requirements for executing in the ASDC production environment (see Section 3.1.2.2). All DMT developed code will include the CERES prologue (CERES Software Bulletin 95-04, see Reference 10).

3.1.2.2 ASDC Production Environment Requirements

All software that executes in the ASDC production environment needs to incorporate the following as a minimum:

- All items identified to standardize contributed code in Section 3.1.1.1.
- All data products will use CERES default values when valid data is not produced.
- Range checking will be performed on all data parameters.
- Metadata files (.met) will be produced for all data products that are archived by ASDC or used by more than one subsystem.

3.1.2.3 Data Product Interfaces

Each data product interface between subsystems will be included in a module that is part of CERESlib. Each of these modules will contain the data structure for the header and a data record, file open with and without Toolkit functions, header read, record read, data parameter ranges, header formatted write routine, data record formatted write routine, and file close with and without Toolkit functions.

3.1.3 Unit Testing

Unit testing is performed by the analyst assigned responsibility for implementing the new requirement. This limited testing may be performed only on the module or package that is changed. Due to the complexity of the CERES software, it is not always efficient to perform tests on individual routines outside of the entire subsystem. In these cases, the unit test may be performed in the analyst's test area using an updated set of baseline code. Unit tests are considered complete when the results of testing in the analyst's test area are successful. In some cases, the subsystem's WG chair may be involved in the approval of the test cases.

3.1.3.1 Testing of Contributed Software

Testing of the Science Team contributed software is frequently conducted with specific input data conditions. The expected results for these specific input conditions must be conveyed to the DMT by the Science Team.

3.1.3.2 Testing of Developed Software

Testing of developed software relies more on the subsystem team to determine suitable test cases and expected results especially during unit testing. The Science Team may only be involved on that portion of testing directly related to the coded algorithm.

3.2 Updates Integrated into Baseline

Once the code modification is completed and confirmed to be operating correctly, it is delivered to the subsystem integrator. Due to the size of the CERES DMT, it is possible that the team member making the update and the subsystem integrator are one and the same. Each subsystem with more than one individual will have procedures for notifying the subsystem integrator that the software is ready, which parts have changed, and how to obtain the software.

3.2.1 Updating Baseline

A development environment is provided at the SCF that is nearly identical to the production environment in processors, operating systems, compilers, and COTS software. The subsystem integrator will have the latest software baseline in the subsystem integration and test directory on an SCF server. Modules or packages that have been updated will replace the existing ones. After setting the environment variables, the code will be compiled. The integrator will work with the analyst to resolve any compilation errors. Once the code has been successfully compiled, the baseline update is completed.

3.2.2 Integration Testing

Integration testing is performed by the subsystem integrator in a designated test area determined by the subsystem on SCF resources. The software will be run through a series of standard tests developed by the subsystem along with specific tests to exercise the updated software. The first step is to replicate any expected results provided in unit testing. A routine set of integration tests will be run, which may include first and last day of year tests, a test for February 29, and seasonal tests. In each case a definition based on the requirement will be used to determine if the desired results were achieved. Once functionality is confirmed, further testing is performed during subsystem science testing.

3.2.3 Maintaining a Baseline

Each subsystem is responsible for maintaining a repository which contains the approved software baseline. The subsystem integrator is responsible for updating and maintaining the repository. Subsystems may use a configuration management tool, such as CVS, to aid in maintaining the baseline; however, the use of a configuration management tool is not required. Maintaining a separate directory structure containing the baseline version of the subsystem software is also acceptable, as long as that directory is in an area that is backed up on a regular basis and procedures for maintaining and updating the baseline are in place for the subsystem. If problems are discovered during testing, updates are made to the baseline to address these issues. The software version that successfully passes all subsystem, CM, and ASDC testing and has been promoted to the operational production environment becomes the starting baseline for the next delivery.

3.3 Subsystem Science Testing

The DMT often must test software using a wider variety of input data conditions than are available in the more routine Integration Testing (see Section 3.2.2). The Science Team is encouraged to assist in the selection of the input data used during this phase of testing.

For each test the results are compared to expected results that are define by the requirements. Due to the research nature of the CERES project, it is often necessary to run various subsystem science integration tests and have the results reviewed by the appropriate CERES WG chair. Sometimes the results from the downstream subsystem may be used to verify the previous subsystem's software changes. For example, the Instrument Subsystem passes test results on to the ERBE-like Subsystem to create reports used by the Instrument Subsystem WG chair for verification of the Instrument software updates.

Also, the interface with the downstream subsystem must be tested to ensure that the incoming data product can still be read and does not break the downstream subsystem's software.

Additional software tools not intended for the production environment have been developed for verification purposes. These tools are designed to analyze the results written to the data products generated by the subsystems. The functions of these tools include, but are not limited to, range

verification and comparisons against baseline data. These tools are also provided to the ASDC SIT team with the software deliveries to help evaluate the success of integrating the subsystem into the production environment.

Approval of the software updates by the subsystem WG chair constitutes the end of the Subsystem Science Testing and the software now moves into pre-CM testing.

3.4 Pre-CM Testing

Pre-CM testing begins once the subsystem's WG chair approves the subsystem science testing. Pre-CM testing is performed in the subsystem testing area of the production environment, therefore this is a validation process. Pre-CM testing begins by moving the delivery package (software and input, ancillary, and any expected output data) into the subsystem's designated test area on the production system. The pre-CM testing must follow the subsystem's Test Plan (see Reference 13), however, it is not limited to only those test cases. It is left to the discretion of the subsystem team to determine if test cases not defined in the subsystem Test Plan are run. These test results are compared to results obtained during subsystem science testing. If the test results are scientifically equivalent to that output, the process to deliver the updated software begins.

3.5 Delivery to CERES CM

The subsystem integrator is responsible for delivering the updated software to CERES CM. Table 3-1 describes the five delivery categories.

Table 3-1. Delivery Category Description

Delivery Category	Description
Full Subsystem	Includes all PGEs with associated source, scripts, ancillary, input, and expected output data files that comprise the complete subsystem delivery.
PGE(s) Specific	Includes all files necessary for the PGE(s) being delivered.
Delta	Includes only scripts and/or data files.
Coefficient	Includes only instrument gain, spectral response function, S'COOL data, GGEO coefficient, or other types of files that need to be periodically delivered.
Sample Read Package	Includes any updates necessary to support reading an output data product whose format was changed.

The Sample Read Package is provided to the ASDC User Services and is distributed to a user when a CERES data product is ordered from the ASDC (see Reference 11). Guidelines on the content to be included in the Sample Read Package are defined by the ASDC User Services (see Reference 11).

The documentation included with Full Subsystem, PGE(s) Specific, and Delta deliveries includes preliminary and final versions of the CERES Delivery Memo (see Reference 12) and, if applicable, updated versions of the subsystem Test Plan (see Reference 13) and Operator's Manual (see Reference 14). Data Products Catalog pages (see Reference 1) for which the subsystem team is responsible are included with a Sample Read Package. No formal documentation is required for Coefficient deliveries.

CERES CM has developed a detailed set of reference material to help subsystem personnel through the delivery process. These materials include:

- Documentation Guidelines
- CERES Subsystem Delivery Schedules
- CERES Subsystem Delivery Procedures
- Clouds S'COOL Data File Delivery Procedures
- CERES File Naming Conventions
- Procedures for Submitting Changes to CERESlib
- the most recent Delivery Memos for each subsystem
- Delivery Memo Sample
- Delivery Memo Template
- the most recent Test Plan for each subsystem
- CERES Subsystem Test Plan Guidelines (CERES Software Bulletin 97-05)
- Test Plan Sample

These can be found at URL: http://earth-www.larc.nasa.gov/cerescm.

4.0 CM Validation and Product Integration Stage

This stage is broken into two tasks as shown in Figure 1-3: CM Testing (see Section 4.1) and Release to SIT (see Section 4.2). These tasks are performed by the CERES CM Team. The CM Testing process consists of compiling the software and executing the appropriate tests as specified in the subsystem Test Plan (see Reference 13) in the SSI&T area of the ASDC production environment. When all tests are successful, the software is released to the ASDC SIT.

4.1 CM Testing

Once a Full Subsystem or PGE(s) specific delivery is made to CERES CM, the delivered files are moved to the SSI&T area in the ASDC production environment. The software is compiled using the procedures provided in the subsystem Test Plan. If compilation is not successful, the subsystem integrator is contacted for resolution.

When the software has been successfully compiled the appropriate tests as described in the subsystem Test Plan are run and the output is compared using the directions provided. Comparison software is generally provided with the delivery to assist in evaluating the results. If the data created are scientifically equivalent to the expected output data files included in the delivery as per the evaluation procedures in the subsystem Test Plan, the CERES CM validation is considered complete. The successful compilation of the software and execution of the test cases acts as an audit of the delivered files.

If a problem is discovered during testing, the subsystem integrator is notified. The subsystem integrator may need to take one of the following actions: correct the Test Plan, provide modified software or data files as an update to the existing delivery, or cancel the delivery. CERES CM testing is resumed in the first two cases when the appropriate update is received. More detailed information on the CERES CM testing and procedures can be found in the CERES Configuration Management Plan (see Reference 8).

4.2 Release to SIT

After the testing is completed, a release notification is sent to the ASDC SIT team to inform them that operational testing may begin.

5.0 ASDC Validation and Verification Stage

The ASDC Validation and Verification Stage consists of testing in the appropriate production environment at the ASDC and of the final evaluation of the output data products by the subsystem and appropriate WG chair. This stage is broken into two tasks as shown in Figure 1-3: Operational Testing at ASDC (see Section 5.1) and ValRx Testing (see Section 5.2). These tasks are not actually performed by the DMT except for evaluating the final results in conjunction with the WG chair. The Operational Testing at ASDC is a part of the validation process as it demonstrates that the product (CERES subsystem software) fulfills its intended use when placed in its intended environment. The ValRx Testing is also a part of the validation process as it is during this testing that the software is first run in the operational production environment. In addition, ValRx Testing is also a part of the verification process as more thorough test cases as specified by the Science Team can be run through the subsystem software in this operational production environment - cases that may still be required to thoroughly ensure that the subsystem software meets its specified requirements. Both the Science Team and DMT carefully review these results as this is the last opportunity to catch errors or inconsistencies with the requirements before operational processing commences.

5.1 Operational Testing at ASDC

The ASDC SIT team uses a suite of tests designed to ensure the software will perform correctly in the operational production environment for product validation purposes. The SIT team also makes any necessary updates to the production scripts. Once all of the tests have completed successfully in the SSI&T area, the software is promoted into the operational production environment for ValRx Testing.

5.2 ValRx Testing

The validation part of ValRx Testing is performed in the operational production environment to ensure that updates made to the production scripts are accurate. Subsystems may test at the SCF with several days of input data (hardware resources limit the amount of data that can be produced) which is approved by the Subsystem's WG chair. However, several days of data are not always adequate to determine the validity of the data products. The ValRx Testing allows several months of data to be processed and verified before the software is released for production. The amount of data used for ValRx Testing is determined on a case by case basis by the subsystem's WG chair and DMT Production Coordinator. The WG chair is responsible for analyzing the results of the verification programs (software developed by or for the Science Team to verify the results of the CERES software) and preparing the Data Quality Summary available through the ASDC ordering tool (see Reference 11).

The subsystem's WG chair and subsystem team review the results from the final validation/ verification testing. The subsystem team generates any statistical tables or graphics requested by the WG chair. Should any algorithm errors be identified, the WG chair makes the decision whether or not to begin production processing. If the decision is not to begin operational production processing, then the algorithm errors are resolved, and the process is repeated as appropriate.

6.0 Checklist for Public Release of Data Products

A checklist has been developed and is maintained by the DMT Production Coordinator (NASA) to ensure that all the necessary software and documentation are updated before a CERES data product is released to the public. The checklist includes tasks not only for the subsystem team, but those to be completed by the subsystem's WG chair, ASDC SIT, and ASDC User Services, along with the DMT Production Coordinator (NASA). The DMT Production Coordinator (NASA) is responsible for maintaining a checklist for each software delivery. This Customer Public Release of Data Products Checklist, as it exists as of January 2006, is available in Appendix C.

7.0 CERES DMT Peer Reviews

Peer reviews are a very important part of the CERES software development process. As their scope does not easily fit into the more chronological context of this SDP, this section will describe CERES DMT peer reviews.

Peer reviews are performed on software and documents as deemed necessary by the DMT or the Science Team based on the following criteria:

- Unexplained errors in data products
- Requested by the customer
- New CERES DMT documentation
- Updating CERES DMT documentation for the first time in 10 years

A peer review team may consist of members from both the CERES Science Team and DMT. There may also be at least one independent reviewer. Team members should be knowledgeable of the subject matter. The author of the item being reviewed must be a member of the peer review team and will lead the review. A team recorder will be appointed to document the review.

The maximum time allotted for a peer review is one week. If more than a week is necessary to review a complete software package or document, they will be divided into smaller components that can be individually reviewed within a week.

The author will initiate the peer review by a formal email announcement that will identify the team, the location of the meeting, the time of the meeting, and the material that will be reviewed. Review material will also be provided.

Team members will bring information to the peer review on the amount of time spent preparing for the review and how many defects were found in the item being reviewed. The recorder will take minutes including preparation time of the various reviewers, the number of defects found by each reviewer, a list of the defects found, and the action items that result from the review including suggested responsibility for the action item. The minutes prepared by the peer review recorder are the only official record of the peer review's proceedings.

An attendance list will also be collected. In addition, where appropriate, marked copies will be provided to the author.

The author will use the official minutes to prepare the action item list containing the action items, the responsible parties, and, ultimately, the resolution of the action items. The resolution to the action items may be conveyed by the responsible party to the author in the form of email or other formal documentation.

The minutes, action item list, and attendance list will be stored on the ASRATSS iSTARS Web site (http://saic-istars.com/ASRATSS/).

References

1. CERES Data Products Catalog (http://asd-www.larc.nasa.gov/ceres/docs.html)
2. CERES Home Page - (http://asd-www.larc.nasa.gov/ceres/ASDceres.html)
3. CMMI Guidelines for Process Integration and Product Improvement, SEI Series in Software Engineering, Mary Beth Chrissis et al., Addison-Klesley, July 2004.
4. SAIC Data Management Plan for the CERES DMS, Version 4, September 2006.
5. CERES On-Line Documentation Web Site (http://asd-www.larc.nasa.gov/ceres/docs.html)
6. CERES Brochure (http://asd-www.larc.nasa.gov/ceres/brochure/intro.html)
7. CERES DMT Requirements Management Plan
8. SAIC Configuration Management Plan for the CERES DMS, Version 5, September 2006.
9. Software Coding Guidelines (http://asd-www.larc.nasa.gov/SCG/SCG.pdf)
10. CERES Software Bulletin 95-04, Revised Standard Routine Prologue (http://asd-www.larc.nasa.gov/ceres/sw_bull/bulletins.html)
11. ASDC Web Site - (http://eosweb.larc.nasa.gov/)
12. CERES Delivery Memo (http://earth-www.larc.nasa.gov/~cerescm/)
13. CERES Subsystem Test Plan (http://asd-www.larc.nasa.gov/ceres/test_plans/)
14. CERES Operator's Manual (http://asd-www.larc.nasa.gov/ceres/ops_man/)
15. CM Web Site (http://earth-www.larc.nasa.gov/~cerescm/)
16. CERES Interface Requirements Document (http://asd-www.larc.nasa.gov/ceres/docs.html)

Appendix A
Abbreviations and Acronyms

ASDC	Atmospheric Sciences Data Center
ASRATSS	Atmospheric Sciences Research and Technology Support Services
ATBD	Algorithm Theoretical Basis Document
CERES	Clouds and the Earth's Radiant Energy System
CERESlib	CERES library
CM	Configuration Management
CMMI	Capability Maturity Model Integrated
COTS	Commercial Off-the-Shelf
CVS	Concurrent Versions System
DMS	Data Management System
DMT	Data Management Team
DPC	Data Products Catalog
EDG	EOS Data Gateway
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
ERBE	Earth Radiation Budget Experiment
ERBS	Earth Radiation Budget Satellite
GGEO	Gridded Geostationary Narrowband Radiances
iSTARS	Internet Status Tracking and Reporting System
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
PAL	Process Area Library
PGE	Product Generation Executable
SAIC	Science Applications International Corporation
SCCR	Software Configuration Change Request
SCF	Science Computing Facility
S'COOL	Students' Cloud Observations On-Line
SDP	Science Data Processing (Toolkit)
SDP	Software Development Plan
SIT	Software Integration and Testing
SS	Subsystem
SSI&T	Science Software Integration and Testing
TISA	Time Interpolation and Space Averaging

TOA	Top of the Atmosphere
TRMM	Tropical Rain Measuring Mission
TSA	Time/Space Averaging
WG	Working Group

Appendix B
Glossary

product: Refers to software delivered to the ASDC for use in production processing.

data product: Refers to the output products created by the software that is used in production processing that are available for release to the Science Team, DMT or the public.

peer review: The review of work products performed by peers during development of the work products to identify defects for removal.

requirement: (1) A condition or capability needed by a user to solve a problem or achieve an objective. (2) A condition or capability that must be met or possessed by a product or product component to satisfy a contract, standard, specification, or other formally imposed documents. (3) A documented representation of a condition or capability as in (1) or (2) [IEEE 610.12-1990].

SSI&T Team: The CERES CM and the ASDC SIT Teams.

Appendix C
Customer Public Release of Data Products Checklist

Satellite: _____

Production Strategy: _____

Product Name: _____

Instructions: Date and initial each line when the task is complete.

_____ Software delivered to CM

_____ Code released to ASDC for operations testing

_____ Sample Read Package delivered to CM and forwarded to ASDC

_____ Code promoted to production

_____ ValRX processed (only required for Editions)

_____ ValRX reviewed and request to begin EditionY sent to Operations

_____ Initial Data Quality Summary inputs sent to User Services

_____ EditionY or BetaY processing started

_____ Data Quality Summary available for review

_____ Final modifications to Data Quality Summary sent to User Services

_____ Data Quality Summary completed and approved by Science

_____ Sample Read Package verified by User Services

_____ Data set release notification sent to User Services & Operations

_____ New data set is correctly listed on CERES Data Sets Webpage

_____ One granule from data set ordered using Langley Ordering Tool

_____ Subsystem lead verified that read package and other order contents are correct

_____ Order one granule of data set from EDG (2-3 weeks after sending release notice) and verify content are the same as what was ordered via Langley Tool